The laryngeal tube compared with the laryngeal mask: insertion, gas leak pressure and gastric insufflation

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Background. We have compared the laryngeal tube and laryngeal mask in 22 patients for the success rate of insertion, gas leak pressure and the incidence of gastric insufflation.

Method. In a randomized, crossover design, the laryngeal tube and laryngeal mask were inserted in turn after induction of anaesthesia and neuromuscular block. The cuffs were inflated until the intracuff pressure reached 60 cm H₂O. We measured adequacy of ventilation and the minimum airway pressure at which gas leaked around the cuff. The presence or absence of gastric insufflation was studied at an inflation pressure of 20 cm H₂O.

Results. It was possible to ventilate through the laryngeal tube in 21 patients and through the laryngeal mask in 21 patients. The mean leak pressure for the laryngeal tube (26 (±5) cm H₂O) was significantly greater than that for the laryngeal mask (19 (±4) cm H₂O) (P<0.01; 95% confidence intervals for mean difference: 5.3–10.2 cm H₂O). Gastric insufflation did not occur when the laryngeal tube was used and was noted in three patients when the laryngeal mask was used.

Conclusion. The laryngeal tube provides a better seal in the oropharynx than the laryngeal mask.

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The laryngeal tube (VBM, Medizintechnik, Germany) (Fig. 1) has been developed to secure a patent airway during spontaneous breathing or controlled ventilation. It consists of an airway tube with a small cuff attached at the tip (distal cuff) and a larger cuff in the middle of the tube (proximal cuff). The cuffs are inflated through a single pilot tube and balloon, through which the cuff pressure can be monitored. There is a standard 15-mm connector on the proximal end of the device so that it can be attached to a breathing system. The device is made of silicone and is reusable after sterilization in an autoclave. Six sizes are available, suitable for neonates to large adults. When the device is inserted, it lies along the length of the tongue, and the distal tip is positioned in the hypopharynx (Fig. 2). The proximal cuff provides a seal by forming a plug in the upper pharynx and the distal cuff seals the oesophageal inlet. There is a distal aperture in the tube between the two cuffs. Three black lines on the tube near the connector indicate adequate depth of insertion when aligned with the teeth.

The laryngeal tube is now commercially available, but there have been only two clinical studies¹², neither of which compared the efficacy of the laryngeal tube with other airway devices. The main aim of this study was to compare the laryngeal tube with the laryngeal mask airway (LMA)¹ in terms of the success of insertion, gas leak pressure and the incidence of gastric insufflation.

Patients and methods

After obtaining approval from the institutional Research Ethics Committee and written informed consent, we studied 22 patients (ASA I or II, aged 18–78 yr, height 148–180 cm, weight 45–81 kg) undergoing elective surgery. Patients with any abnormality of the neck, upper respiratory tract or upper alimentary tract, or at risk of regurgitation of gastric

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contents were excluded. Patients with Mallampati class 3 or 4 were also excluded.

In the anaesthetic room, an electrocardiograph, a pulse oximeter and an arterial pressure cuff were attached and an i.v. cannula was inserted. A firm pad (7 cm in height) was placed under the patient’s occiput. After the patient had breathed oxygen through a facemask for a minimum of 3 min, anaesthesia was induced with a sleep dose of propofol 2.0–3.0 mg kg⁻¹ i.v., supplemented with fentanyl 2 μg kg⁻¹. Neuromuscular block was obtained with vecuronium and was confirmed using a peripheral nerve stimulator. Anaesthesia was maintained with a continuous infusion of propofol while the patient was breathing oxygen (but not nitrous oxide) until the end of the study.

In a randomized, crossover design, the laryngeal tube and laryngeal mask were inserted in turn. The order was randomized by tossing a coin. Three anaesthetists were involved in insertion of these devices. All of them had used the laryngeal mask routinely for between 2 and 12 yr. One anaesthetist had used the laryngeal tube more than 100 times, whereas the other two had used it fewer than 10 times before the start of the study.

The sizes of laryngeal tube¹ and laryngeal mask⁵ according to the patient’s height are shown in Table 1. The laryngeal tube was inserted into the oropharynx by the following method. Before insertion, the cuffs were deflated and a water-soluble lubricant (KY jelly) was applied to the cuffs. The patient’s neck was extended (‘sniffing position’). The tip of the laryngeal tube was placed against the hard palate behind the upper incisors and the device was slid down in the centre of the mouth until a resistance was felt or the second bold black line on the tube (Fig. 1) had just passed between the upper and lower teeth. The cuffs were inflated using a cuff inflator (VBM, Medizintechnik, Germany) until the intracuff pressure reached approximately 60 cm H₂O.¹ The laryngeal mask was inserted using the technique described in the manufacturer’s instruction manual, and its cuff inflated using the cuff inflator until the intracuff pressure reached approximately 60 cm H₂O.⁶

After insertion of the device being tested, we connected the breathing system and assessed adequacy of ventilation by gently squeezing the reservoir bag and observing the presence of end-tidal carbon dioxide waveforms and chest movement. If it was not possible to ventilate the lungs, the position of the test device was adjusted by gently pushing or pulling it. Adequacy of ventilation was then re-assessed. If it was not possible to insert the device or ventilate through it, one more attempt at insertion of the device was allowed. If placement had failed after two attempts, the study was abandoned and the airway was maintained through either a facemask or a tracheal tube.

If ventilation was possible, the device was fixed to the patient by the following methods: for the laryngeal tube, the bite block provided was inserted, the laryngeal tube snapped into its wedge and both were fixed using sticky tape (Fig. 1). For the laryngeal mask, a wad of gauze was inserted into the patient’s mouth and both were fixed using sticky tape. After fixation of the device, the airway pressure was initially maintained at 18 cm H₂O by squeezing the reservoir bag for
The inflation pressure was measured using an airway pressure gauge. If there was no gas leak, airway pressure was increased at each breath by 2 cm H$_2$O, whereas if there was gas leak, airway pressure was decreased at each breath by 2 cm H$_2$O. The airway pressure at which gas leaked around the test device was recorded. The adequacy of ventilation was scored in the five categories shown in Table 2.

The presence or absence of gastric insufflation was then studied at the inflation pressure of 20 cm H$_2$O by auscultation over the epigastrium. It has been shown that a volume of gas, as little as 5 ml, entering the stomach from the oesophagus can be detected.\textsuperscript{7,8} The cuff of the test device was then deflated and the device removed. The volume of air withdrawn from the cuff was recorded.

Our main interest was to compare the leak pressures between the laryngeal tube and laryngeal mask, and thus the number of patients required was calculated on the basis of this factor. The mean airway pressure at which gas leaks around the laryngeal mask has been reported to range from 18 to 20 cm H$_2$O (SD approximately 5 cm H$_2$O).\textsuperscript{9} We considered that an increase in the leak pressure to 25–26 cm H$_2$O (i.e. a 30% increase) would be a clinically important difference. Twenty-two patients would be required to detect this difference with a power of 80% (if comparison was made between two independent groups). For gastric insufflation, we did not plan to apply any hypothesis for comparing the groups, since the number of patients we planned to study could be too small to detect a difference, and because the clinical significance of this observation during such a short period of time at a fixed airway pressure (20 cm H$_2$O) was not certain.

Plots of normal scores showed that the data for the differences in the leak pressures between the laryngeal tube and laryngeal mask were normally distributed, and thus a paired $t$-test was used for comparison. $P<0.05$ was considered significant. The 95% confidence intervals (CI) for the difference in the mean leak pressure between the laryngeal tube and the laryngeal mask were also calculated.

### Results

We studied nine women (four at least 155 cm tall and five less than 155 cm tall) and 13 men (all at least 155 cm tall).

It was possible to insert and ventilate through the laryngeal tube in 21 of 22 patients (without changing its position after inflation of the cuffs). Ventilation was adequate at the first attempt in 19 patients and at the second attempt in another two patients. Adequate ventilation was not possible after two attempts in the remaining one patient. It was possible to insert and ventilate through the laryngeal mask in 21 of 22 patients. Ventilation was adequate at the first attempt in 20 patients and at the second attempt in another one patient. Adequate ventilation was not possible in the remaining one patient.

The mean volume of air placed in the cuff to give the intracuff pressure of 60 cm H$_2$O was 75 (SD 8) ml for the laryngeal tube and 19 (4) ml for the laryngeal mask. The minimum mean airway pressure at which gas leaked around the cuff of the laryngeal tube was 26 (5) cm H$_2$O, which was significantly greater than that of the laryngeal mask (19 (4) cm H$_2$O) ($P<0.01$; 95% CI for mean difference: 5.3–10.2 cm H$_2$O) (Fig. 3). When the laryngeal tube was used, gas did not leak around the cuff at an airway pressure of 30 cm H$_2$O in 12 of 22 patients (55%), whereas when the laryngeal mask was used gas always leaked around the cuff with an airway pressure of less than 30 cm H$_2$O (Table 2).

Gastric insufflation did not occur in any patient when the laryngeal tube was used, and was noted in three of 22 patients when the laryngeal mask was used.

<table>
<thead>
<tr>
<th>Category</th>
<th>Airway pressure at which gas leak occurred</th>
<th>Laryngeal tube</th>
<th>Laryngeal mask</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>No gas leak at 30 cm H$_2$O</td>
<td>12 (55)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Good</td>
<td>18–28 cm H$_2$O</td>
<td>8 (36)</td>
<td>15 (68)</td>
</tr>
<tr>
<td>Fair</td>
<td>10–16 cm H$_2$O</td>
<td>1 (5)</td>
<td>6 (27)</td>
</tr>
<tr>
<td>Poor</td>
<td>8 cm H$_2$O or less</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Failure</td>
<td>Failed insertion or failed ventilation</td>
<td>1 (5)</td>
<td>1 (5)</td>
</tr>
</tbody>
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3 s. The inflation pressure was measured using an airway pressure gauge. If there was no gas leak, airway pressure was increased at each breath by 2 cm H$_2$O, whereas if there was gas leak, airway pressure was decreased at each breath by 2 cm H$_2$O. The airway pressure at which gas leaked around the test device was recorded. The adequacy of ventilation was scored in the five categories shown in Table 2.

The presence or absence of gastric insufflation was then studied at the inflation pressure of 20 cm H$_2$O by auscultation over the epigastrium. It has been shown that a volume of gas, as little as 5 ml, entering the stomach from the oesophagus can be detected.\textsuperscript{7,8} The cuff of the test device was then deflated and the device removed. The volume of air withdrawn from the cuff was recorded.
Discussion
The success rate of obtaining a patent airway through the laryngeal tube was high (95%). This result is consistent with previous reports, in which success rate was 94–100%. We also found that the laryngeal tube provided a patent airway as frequently as the laryngeal mask.

The laryngeal tube provided a good airtight seal in most patients (Table 2), and often there was no gas leak around the cuff at an airway pressure of 30 cm H₂O. The leak pressure for the laryngeal tube was significantly higher than that for the laryngeal mask (Fig. 3).

Compared with the laryngeal mask, the laryngeal tube provided a significantly better seal to the oropharynx. In addition, gastric insufflation did not occur in any of 22 patients when the laryngeal tube was used, whereas it occurred in three patients when the laryngeal mask was used. Therefore, the laryngeal tube may be more suitable than the laryngeal mask during intermittent positive-pressure ventilation. However, studies of the laryngeal tube are few, with only a few preliminary reports of its efficacy during the entire course of anaesthesia and of postoperative complications such as sore throat or lingual nerve palsy. Therefore, caution is required with the results obtained in this study until the safety of the routine use of the laryngeal tube during anaesthesia is known.

Acknowledgement
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References